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INTEROFFICE MEMORANDUM

DATE February 15, 1996

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SUBJECT GROUNDWATER CONCEPTUAL PLAN – ALP-001-96

Attached is a copy of the Final Conceptual Plan for Groundwater Remediation for internal review Please return comments by close of business Monday, February 19, 1996

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Conceptual Plan for the Management and Remediation of Groundwater at the Rocky Flats Environmental Technology Site

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FINAL

Conceptual Plan for the Management and Remediation of Groundwater at the Rocky Flats Environmental Technology Site

Rocky Mountain Remediation Services, L. L. C.

Environmental Restoration/Waste Management

Sitewide Actions

February 1995

Revision 1

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EXECUTIVE SUMMARY

A sitewide conceptual strategy has been developed to address groundwater issues at the Rocky Flats Environmental Technology Site (RFETS) The groundwater strategy is directly related to the cleanup of contaminated soil and the protection of surface water quality Proposed remedial actions will be protective of surface water quality

Addressing groundwater on a sitewide basis will allow for effective coordination of groundwater activities, a consistent approach to addressing groundwater contamination, and establishment of consistent remediation goals Overall, the programmatic goals are to protect human health and the environment (i e , on and offsite), limit potential contaminantion of water

The goal of the Groundwater Conceptual Plan is to provide a strategy consistent with the Vision and the Action-Level Framework for surface water, groundwater, and soils, to identify and describe the salient groundwater plumes, rank the groundwater plumes in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995), and propose the next steps

Domestic use of groundwater at RFETS will be prevented through institutional controls Since no human exposure to groundwater is foreseen, action levels for groundwater must be protective of surface standards and quality as well as the ecological resources

The volatile organic compound (VOC) groundwater plumes at RFETS have been defined on the basis of exceedances above the maximum contaminant level (MCL) for individual constituents To delineate areas of highly contaminated groundwater, the proposed groundwater action levels of 100 x MCLs were compared against all groundwater data for the most common VOCs in groundwater and the exceedances were plotted

There are six groundwater contaminant plume areas identified where groundwater contamination exceeds 100 x MCLs In addition, groundwater contaminant plumes with concentrations that do not exceed 100 x MCLs, but have the potential to impact surface water discussed as a seventh plume area These groundwater contaminant plumes areas are (1) IHSS 119 1 Groundwater Contaminant Plume, (2) Mound Site Groundwater Contaminant Plume, (3) 903 Pad and Ryan's Pit Plume, (4) IHSS 118 1 Plume, (5) East Trenches Area Plume, (6) IA Plume, and (7) Landfill and Solar Ponds Groundwater Contaminant Plumes

The groundwater plumes were ranked in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995) The plume ranking in this document will be incorporated into the previously developed IHSS ranking

Proposed conceptual actions will result from applying the action levels for groundwater remediation within the framework of the Vision

Further analysis will determine optimal locations, treatment methodologies, and cost-effective project sequencing Alternatives analyses for proposed remedial action will be presented as an Interim Measure/Interim Remedial Action (IM/IRA) decision document or Proposed Action Memorandum (PAM)

1.0 INTRODUCTION

The Groundwater Conceptual Plan has been developed as a joint effort between the Department of Energy Rocky Flats Field Office (DOE/RFFO), Kaiser-Hill, L L C (KH), Rocky Mountain Remediation Services, L L C (RMRS), the Environmental Protection Agency (EPA), Region VIII, and the Colorado Department of Public Health and Environment (CDPHE) This groundwater plan incorporates the draft Rocky Flats Conceptual Vision (dated November 8, 1995 [Appendix B]), and technical guidance from the Groundwater Strategy Working Group and the Action Levels and Standards Working Group

1.1 VISION AND ACCELERATED SITE ACTION PLAN (ASAP)

The Rocky Flats Conceptual Vision identifies the proposed future site conditions for different areas at the Rocky Flats Environmental Technology Site (RFETS) The Vision recognizes that RFETS cannot be returned to a pristine condition and defines four final site conditions These conditions include (1) capped areas underlain by long-term waste management facilities or contaminated materials closed in-place, (2) an industrial area (IA), (3) an inner buffer zone and windblown plutonium area managed as open restricted space, and (4) an unrestricted outer buffer zone that will be managed as open space, but which could be used for any purpose

A comprehensive action plan (i e , ASAP) is being formulated to describe how to implement the Vision in compliance with the Rocky Flats Compliance Agreement (RFCA) This Groundwater Conceptual Plan will help define the requirements for ASAP, and will describe the groundwater management and actions necessary to attain the Vision

The groundwater plan conceptually describes how groundwater will be remediated and managed to protect surface-water quality and the ecology Groundwater management and cleanup will focus on protecting surface-water quality, since there will be no consumptive use of onsite groundwater This prohibition against using onsite groundwater will aid in maintaining hydraulic gradients (i e , vertical and horizontal) to minimize contaminant migration Nevertheless, groundwater quality in the outer buffer zone will be protective for all uses

1.2 PURPOSE OF THE GROUNDWATER CONCEPTUAL PLAN

Groundwater at RFETS is present in the subsurface throughout the site In the past, each Operable Unit (OU) investigated groundwater within its boundaries without addressing influences from upgradient sources However, groundwater is not limited by OU or Individual Hazardous Substance Site (IHSS) boundaries Several sources may contribute to a single groundwater

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plume, and groundwater plumes may cross several units, and contribute to surface-water contamination at some distance from the source location Therefore, a sitewide technical and regulatory strategy has been developed to address groundwater issues at RFETS

The Groundwater Conceptual Plan addresses groundwater on a sitewide basis to allow for effective coordination of groundwater activities, a consistent approach to addressing groundwater contamination, and establishment of consistent remediation goals Development of a sitewide groundwater strategy also means that groundwater remediation can be performed independent of source remediation As there is no exposure pathway to humans, the programmatic goals are to protect surface water and the environment, and limit potential contaminant migration (to the extent possible)

The specific goals of this Conceptual Plan are to

1) Provide a groundwater strategy consistent with the Vision and the Action-Level Framework,

2) Identify and describe the principal contaminated groundwater plumes,

3) Rank the contaminated groundwater plumes for the purpose of establishing the priority for remedial actions in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995), and

4) Provide an initial planning basis for funding and implementation of groundwater remediation

To meet these goals, the strategy proposes source removal, where feasible, provides for source control, where necessary, and provides for the treatment of dissolved-phase plumes, where necessary The strategy includes an evaluation whereby some areas of contaminated groundwater may remain in place if the goals of the strategy can be met without active intervention Downgradient wells will continue to be monitored to ensure that the goals of the strategy are still met

1 3 DOCUMENT ORGANIZATION

The strategy for groundwater restoration is presented in seven sections (1) Section 1 0 provides an introduction, describes the goals and purpose of the groundwater strategy, and presents the organization of the report, (2) Section 2 0 provides a summary background on groundwater at

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RFETS, (3) Section 3 0 presents the cleanup standards and approach developed by the Standards Working Group for surface water, groundwater, surface soil, and subsurface soil and describes the monitoring associated with groundwater restoration and plume management, (4) Section 4 0 describes the various groundwater contaminant plumes present at RFETS and provides an overview of the potential remediation techniques that may be used, and (5) Section 5 0 summarizes the next steps and presents the conclusions

This document also contains three appendices (1) Appendix A is a list of acronyms used in this text, (2) Appendix B contains the text of the draft Conceptual Vision for RFETS, used as the basis for the groundwater strategy, and (3) Appendix C contains the draft Action-Level Framework for Surface Water, Groundwater, and Soils developed by the Standards Working Group

Figure 1-1 is a location reference map showing the central portion of RFETS The principal areas discussed in the text are indicated by annotations

2.0 GROUNDWATER AT RFETS

The physical setting is important to understanding the nature of groundwater flow and contaminant transport at RFETS Shallow groundwater flow can be described as occurring through two distinct layers, each exhibiting common hydrologic characteristics allowing for grouping into two hydrostratigraphic units These units are generally referred to as the (1) upper hydrostratigraphic unit (UHSU) and (2) lower hydrostratigraphic unit (LHSU)

The UHSU is the predominant water-bearing unit of concern at RFETS It consists of sandy and gravely soils mixed with clay (i e , alluvium, colluvium, and artificial fill) as well as weathered bedrock and minor bedrock sandstones hydraulically connected to the alluvium The LHSU consists of unweathered claystone, with some interbedded siltstones and sandstones There is a significant difference in each units' ability to allow groundwater flow For example, the typical hydraulic conductivity values for the Rocky Flats Alluvium are about 2×10^{-4} centimeters per second (cm/sec), while the unweathered Laramie claystones exhibit hydraulic conductivity values of 3×10^{-7} cm/sec, similar to that required for a landfill liner (EG&G, 1995a) However, neither the UHSU nor the LHSU has sufficient transmissivity to be developed as a water source for residential use, although some isolated (i e , UHSU) bedrock sandstones in OU 2 and valley-fill alluvial materials in Walnut Creek near Indiana Street could provide sufficient water to support limited household-use

The spread of contamination in groundwater at RFETS is limited by hydrogeologic conditions Generally, groundwater flows slowly at RFETS The speed of groundwater moving through the Rocky Flats Alluvium in the East Trenches Area is estimated to be about 50 feet per year Because natural processes inhibit or retard the transport of contaminants in groundwater, the speeds at which chlorinated solvents are transported at this location are estimated to range between 2 5 and 25 feet per year

The LHSU provides natural vertical containment for the impacted UHSU groundwater Directly underlying the IA, low permeability claystones of the LHSU form a barrier no less than 500 feet in thickness effectively preventing contamination from migrating to the Laramie/Fox Hills aquifer (See Figure 2-1) By comparison, the average RCRA landfill is lined with two to four feet of similar material As a result of these stratigraphic relationships, all contaminated groundwater emerges as surface water before leaving the site In addition, there is no known hydraulic connection between domestic wells located offsite and impacted groundwater at Rocky Flats Horizontal spread of the plumes is mitigated by the low hydraulic conductivity, lack of continuous permeable beds and high contaminant retardation factors characteristic of the clayrich units comprising the UHSU High contaminant retardation in clayey soils is caused by the small pores inhibiting the passage of the contaminants as well as the process of adsorption

Groundwater in the UHSU preferentially flows along pre-existing channels cut into the bedrock (See Figure 2-2) These channels are known to occur in the IA, Solar Ponds, 881 Hillside, 903 Pad, and East Trenches Areas Other hydrogeologic controls for groundwater flow and contaminant transport are hydraulic gradient, distribution of subcropping sandstones and claystones, and topography In addition, groundwater in the IA may preferentially flow along buried sewer lines and process-waste lines Groundwater in the surficial deposits of the UHSU generally flows to the east, following bedrock and surface topography and discharges to surface drainages where surficial deposits are intersected by drainages These drainages are the main groundwater pathways offsite The surface-water flow onsite is controlled by artificial impoundments in these drainages

The available hydrogeologic and isotopic data suggest that faults are not significant conduits for downward vertical groundwater flow to deep aquifers Evidence of limited hydraulic communication between UHSU and LHSU groundwater was found to exist in some wells, but these occurrences do not present a consistent pattern with known fault locations Isolated fractures in unfaulted bedrock, as opposed to fault zone fractures, are implicated as the most likely mode of transport for UHSU groundwater to reach unweathered bedrock Due to the thickness and lithology of the LHSU, it is likely that fault zones become more impermeable with depth, thus reducing the potential for any shallow groundwater flow to the Laramie/Fox Hills aquifer

Detailed studies of the hydrogeology are presented in the "Hydrogeologic Characterization Report for the Rocky Flats" (EG&G, 1995a) Detailed studies of the geology are presented in the companion document, "Geologic Characterization Report of the Rocky Flats Environmental Technology Site " (EG&G, 1995b) Plume configurations used in the Strategy were derived from the 1995 Well Evaluation Project

Insert Figure 2-1

Insert Figure 2-2

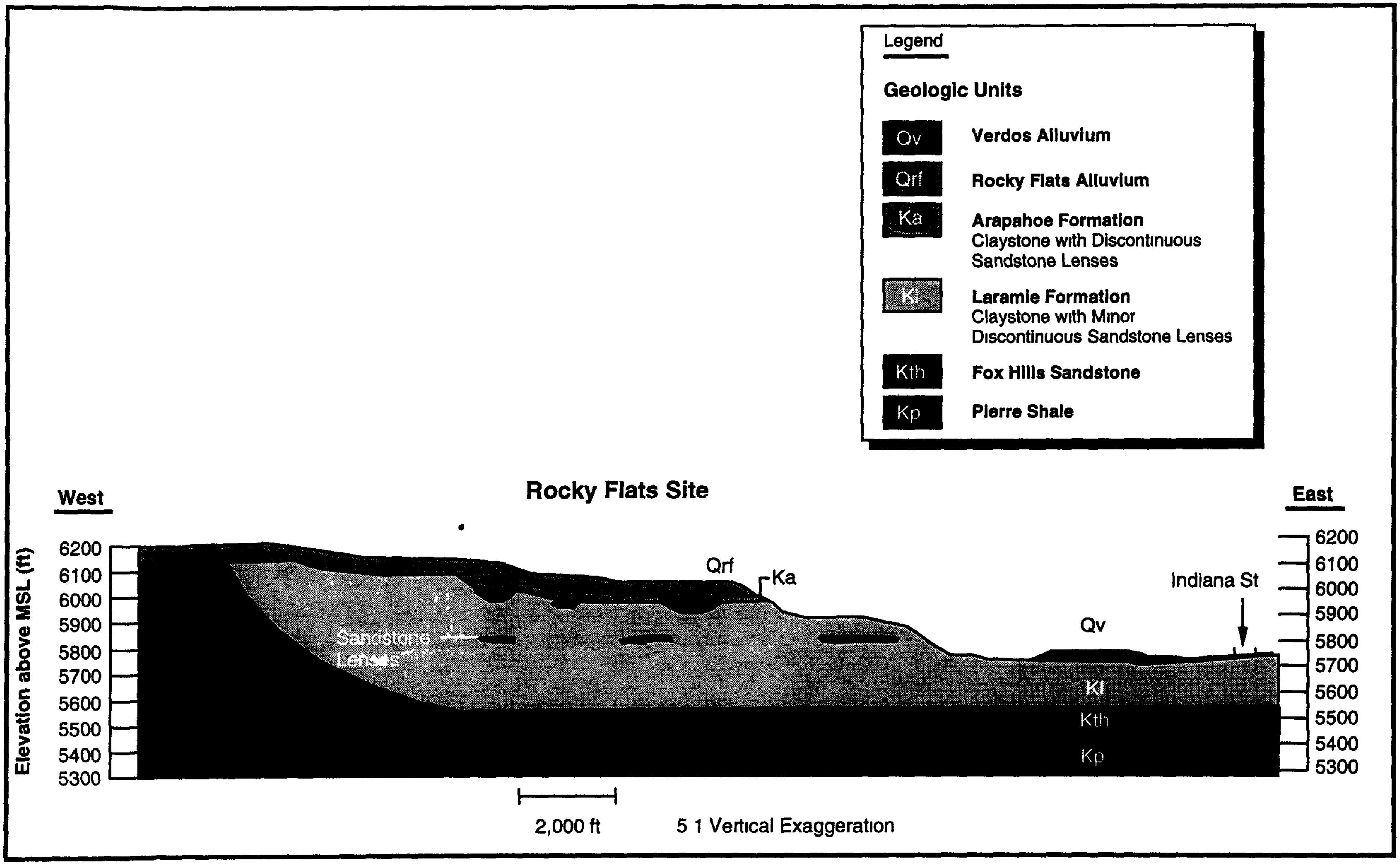

Figure 2-1 Generalized Geologic Cross-Section of the Rocky Flats Area

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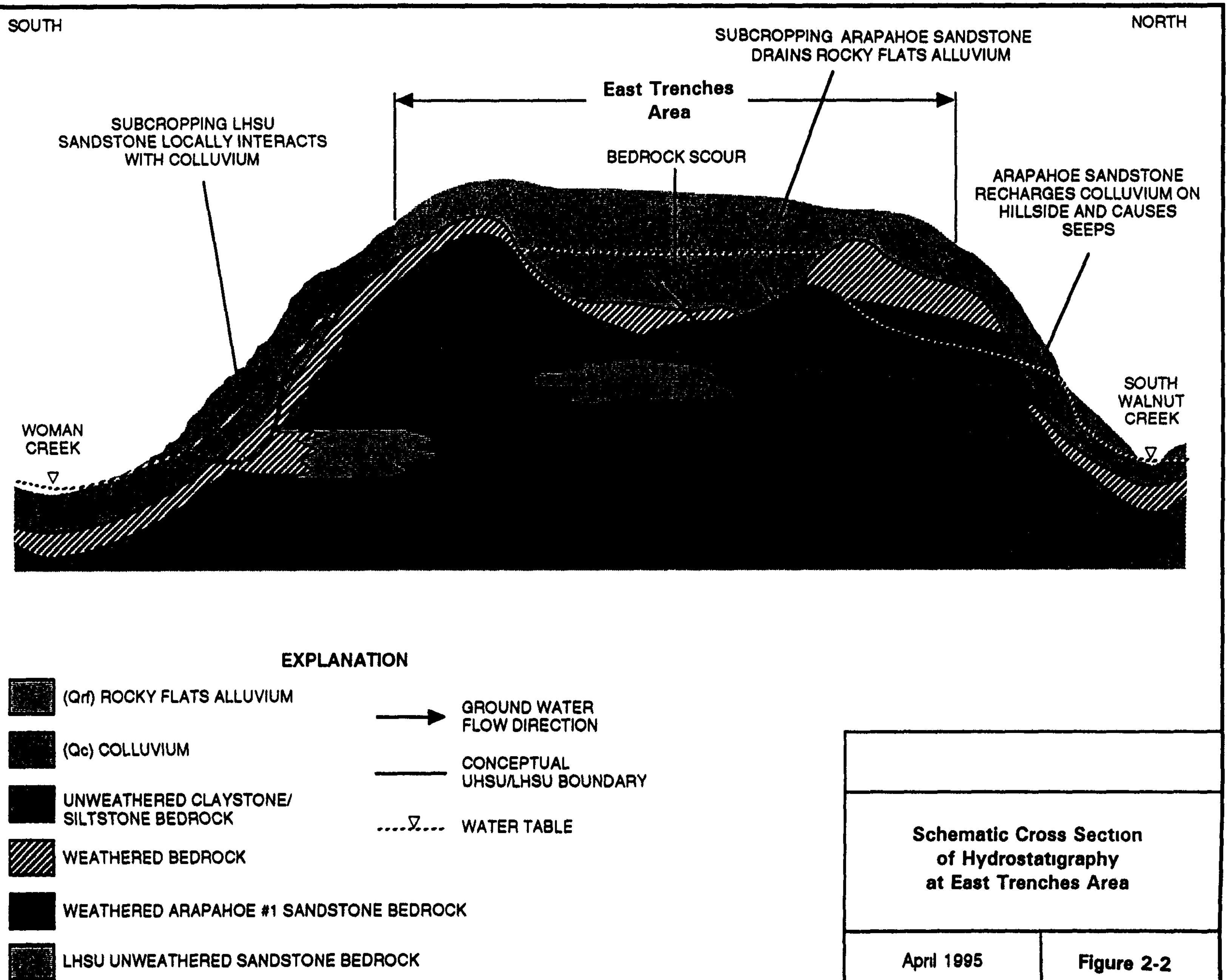

Schematic Cross Section of Hydrostatigraphy at East Trenches Area

April 1995

Figure 2-2

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3.0 ACTION LEVELS AND CLEANUP STANDARDS/GOALS

The Vision is the basis of the standards and action levels developed by the Working Group The draft Conceptual Vision for RFETS places the greatest emphasis on protecting the quality of surface water and minimizing the migration of contaminants offsite through a surface-water pathway Protection of surface water is the primary driver for the cleanup and stabilization of contaminated subsurface soil and groundwater at RFETS Surface water, groundwater, and soil cleanup are interrelated, and the Groundwater Strategy Working Group considered all three media in developing a sitewide strategy for RFETS

The result of the Action Levels and Standards Working Group, (DRAFT) Action-Level Framework for Surface Water, Groundwater, and Soils (February 5, 1996) is attached as Appendix C The parties have not reached agreement on all of the text in this document The following sections summarize the approaches delineated in the draft Action-Levels document for monitoring and remediation of surface water, groundwater, and subsurface soils as these apply to groundwater

3 1 SURFACE WATER

Groundwater will be managed to protect surface water During active remediation, surface-water standards and surface-water management will be different than those applied after remediation The design of systems should include meeting action levels and cleanup standards upon completion of the remediation plans

3.2 GROUNDWATER

As stated in the draft Conceptual Vision, domestic use of groundwater at RFETS will be prevented through institutional controls Because no other human exposure to groundwater is foreseen by the Vision, groundwater action levels are not based on human consumption or direct contact Instead, action levels for groundwater have been selected to be protective of surface-water quality and ecological resources This framework for groundwater action levels is based on the conclusion that all contaminated groundwater emerges as surface water before leaving the site

3 2.1 Action Levels

The action levels and standards working group has defined the action levels based on federal drinking water standards' Maximum Contaminant Levels (MCLs) (see Appendix C) These standards are established and well accepted values which have also been used to guide cleanup at

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other contaminated sites A two-tier approach to groundwater remediation and monitoring is presented in the following paragraphs

Tier-I

Action levels were developed to drive near-source remediations in areas where groundwater contamination exceeds 100 x MCL levels for organic contaminants These action levels are designed to identify groundwater contaminant sources that present a higher potential risk to surface water and that should be addressed through an accelerated action If Tier-I action levels are exceeded, an evaluation is required to determine if remedial or management action is necessary to prevent more highly contaminated (i e , contaminant concentrations exceed 100 x MCLs) groundwater from reaching surface water (the evaluation process is described in Section 4 1) If action is necessary, the type and location of the action will be delineated and implemented as an accelerated action Additional groundwater that does not exceed the Tier-I action levels may also need to be remediated or managed to protect surface-water quality or ecological resources The plume areas to be remediated and the cleanup levels or management techniques used will be determined on a case-by-case basis

Tier-II

The VOC action levels for surface-water protection were developed to prevent contaminated groundwater from reaching surface water, by triggering groundwater management actions when necessary A detailed discussion of where Tier-II action levels will be measured is found in Section 3 2 of Appendix C Table 3-1 presents a list of three new wells and a subset of existing groundwater monitoring wells that are designated as Tier-II monitoring locations Figure 3-1 shows the location of Tier II monitoring wells relative to the composite VOC plumes defined by constituent concentrations greater than the MCLs Additional Tier-II monitoring wells may be installed, if necessary The following paragraph reflects the recommend option made by the Working Group regarding Tier-II wells triggering action (see Section 3 3 of Appendix C)

If concentrations in a Tier-II well exceed MCLs during a regular sampling event, monthly sampling of that well will be required Three consecutive monthly samples showing contaminant concentrations greater than groundwater action level will require a groundwater remedial action These actions will be determined on a case-by-case basis and will be designed to treat, contain, manage, or mitigate the contaminant plume Such actions will be incorporated into the Environmental Priority List and will be given weight according to measured impacts to surface water

The existing proposed Tier II wells are currently in the groundwater monitoring network The new Tier II monitoring wells will be added to the groundwater monitoring network upon completion of well installation and development activities The results of groundwater sampling and analysis will be integrated with concurrent surface water data for the purpose of evaluating potential impacts to surface water

Table 3-1 Tier-II Groundwater Monitoring Wells for VOCs

Location Code	Comments
6586	
New Well	Upstream of 6586
New Well	Between B-2 and B-3
75992	
06091	
New Well	Near C-1 (Downgradient of Ryan's Pit)
10194	
1986	
10994	
P314289	
P313589	
7086	
10992	
1786	
1386	
10692	
4087	
B206989	

Groundwater Monitoring

The groundwater monitoring network will continue to operate as recently modified by the Groundwater Monitoring Working Group, unless subsequent changes are agreed to by all parties Analyte suites, sampling frequency, and specific monitoring locations will be evaluated annually to adjust to changing hydrogeologic conditions such as plume migration and increased understanding of contaminant distributions All groundwater monitoring data, as well as changes in hydrogeologic conditions and any exceedance of groundwater standards, will be reported quarterly and summarized annually to all parties

All long term monitoring requirements for the Site, including those wells that are identified in the groundwater strategy, will be incorporated into the Groundwater Monitoring and Assessment Plan (GMAP) This document will incorporate two pre-existing plans (1) the Groundwater Protection and Monitoring Program Plan (GPMPP) (DOE, 1993) and (2) the Groundwater Assessment Plan (GWAP) (DOE, 1992a)

The GMAP will list the wells with their appropriate regulatory driver, the sampling frequency, and analyte suite as well as describe data evaluation and reporting methodologies The GMAP will also reference other implementation plans and decision documents from which the requirements are derived The GMAP will be updated regularly as programmatic changes occur
If quarterly reporting shows that previously uncontaminated wells are contaminated above groundwater standards, the sampling frequency will be increased to monthly Three consecutive monthly samples showing exceedances will trigger an evaluation to determine if a remedial or management action is necessary

All groundwater remedies, as well as some soil remedies, will require groundwater performance monitoring The amount, frequency, and location of any performance monitoring will be based on the type of remedy implemented and will be determined on a case-by-case basis within decision documents

3.3 SUBSURFACE SOILS

Action levels for volatile organic compounds (VOCs) in subsurface soils were developed to be protective of groundwater in order to protect surface water Metals and radionuclides were not included because they are not generally mobile in groundwater However, it is recognized that locally, metals and radionuclides are present in groundwater at concentrations or activities exceeding background levels Where these metal and radionuclide exceedances coincide with VOC contaminant plumes, the selected remedy will address all contaminants of concern The remaining isolated exceedances of metals and radionuclides will be evaluated with respect to possible impact to surface water and will be reported upon in the Annual RCRA Groundwater Monitoring Report that will be expanded to include a Sitewide as well as a regulated unit analysis The level of soil contamination protective of groundwater was determined using a soil/water partitioning equation and a calculated dilution factor (EPA, 1994) The partitioning equation used chemical-specific parameters and site-specific subsurface media characteristics to determine the equilibrium partitioning of a given contaminant between the soil and groundwater The dilution factor accounts for dilution up to the edge of the source location Using this approach, subsurface soil contaminant levels that would be protective of groundwater to 100 x MCLs were calculated (see Appendix C)

4.0 GROUNDWATER CONTAMINANT PLUMES AND REMEDIATION

4.1 IDENTIFICATION

The VOC groundwater contaminant plumes at RFETS have been defined on the basis of exceedances above the MCL for individual constituents (see Figure 3-1) To delineate areas of highly contaminated groundwater, the proposed groundwater action levels of 100 x MCLs were compared against all groundwater data for the most common VOCs in groundwater The exceedances were plotted and are shown on Figure 4-1 The most probable sources were identified using the results of recent field sampling programs and process knowledge The flow diagram (see Figure 4-2) describes the method used to locate groundwater contaminant plumes and the corresponding sources, and to determine which areas should be targeted for remedial action

There are six groundwater contaminant plume areas identified where groundwater contamination exceeds 100 x the MCLs In addition, groundwater contaminant plumes with concentrations that do not exceed 100 x MCLs, but are of high interest are discussed as a seventh plume area Contaminated groundwater flows slowly at RFETS, and it appears that these plumes have reached a stable configuration These groundwater contaminant plumes areas are (1) IHSS 119 1 Groundwater Contaminant Plume, (2) Mound Site Groundwater Contaminant Plume, (3) 903 Pad and Ryan's Pit Plume, (4) IHSS 118 1 Plume, (5) East Trenches Area Plume, (6) IA Plume, and (7) Landfill and Solar Ponds Groundwater Contaminant Plumes

The 903 Pad and Ryan's Pit plume, the Mound, and the East Trenches plumes are part of a large composite groundwater contaminant plume on the east side of the plant Even though these component plumes overlap, differing sources and flow paths make it effective to treat these parts of the large plume individually

4.2 GROUNDWATER REMEDIATION

4 2.1 Remediation Alternatives

The goal of this strategy is to manage and/or remediate groundwater to be protective of surface water The proposed remediation of contaminated groundwater plumes involves source removal or source containment with treatment or management of the contaminated groundwater to minimize impacts on surface water The conceptual remedies for each groundwater contaminant plume were developed by assessing the available technologies, and proposing a cost effective, readily available technology

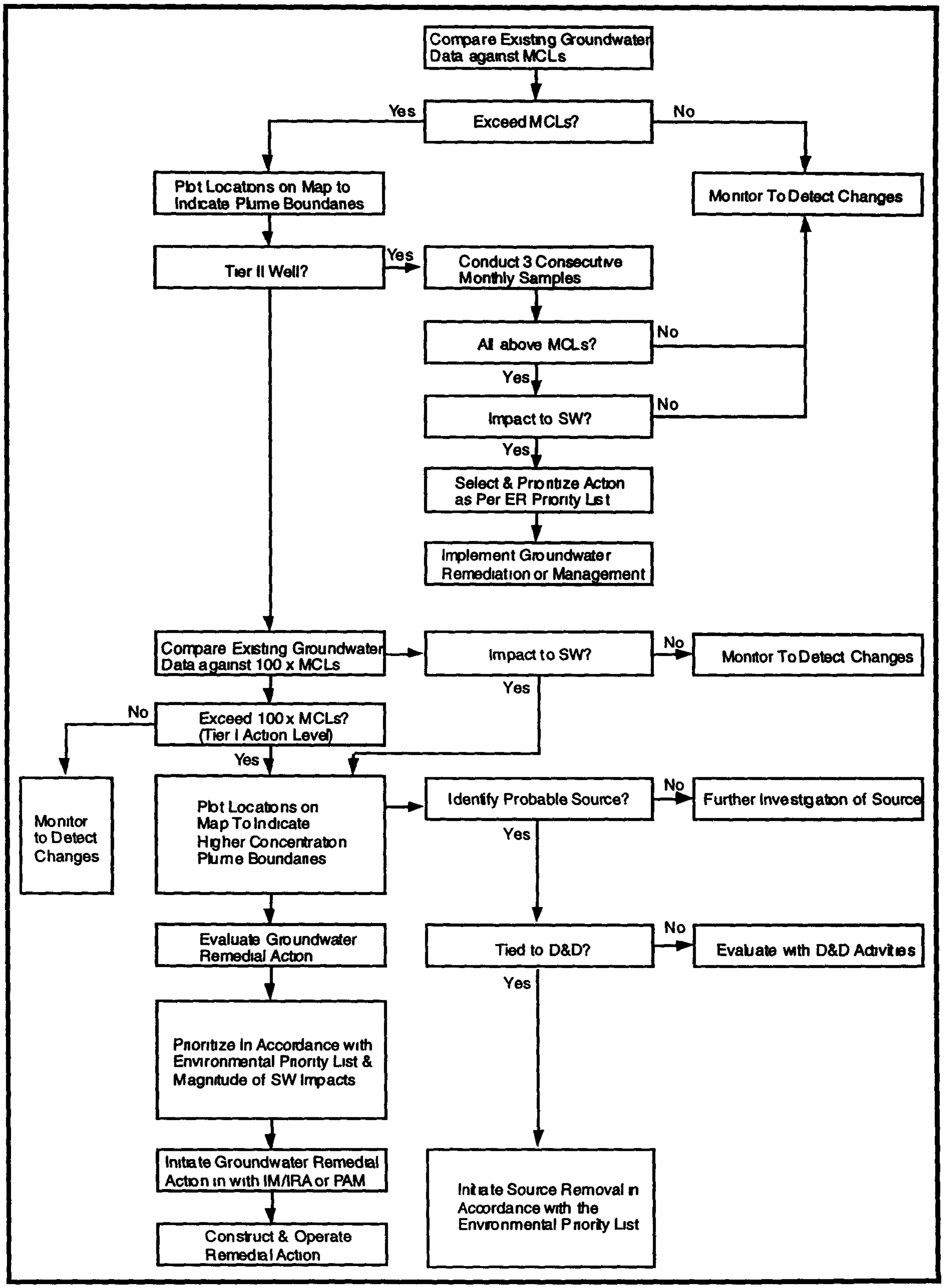

Figure 4-2 Flow Diagram

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Active and passive remedial actions were initially considered Active treatment actions such as pump and treat are well known and accepted, but often have high operation and maintenance costs, can have a negative impact on wetlands, may consume groundwater, and are relatively inefficient for dense nonaqueous phase liquid (DNAPL) remediation Passive treatment actions include passive collection of groundwater with *ex situ* treatment and *in situ* collection and treatment These systems may have higher capitol costs, but have lower operation and maintenance costs, low energy consumption, no water consumption, reduced equipment requirements, and are effective for DNAPLs

The pump and treat methodology is commonly used and accepted EPA has identified the pump and treat methodology as one of the most common methods for groundwater remediation, but recognizes that pump and treat methods may require decades of potentially expensive operations to achieve cleanup levels (EPA, 1992) A preliminary analysis was performed on the potential effectiveness at RFETS The analysis concluded that pump and treat would not be an effective treatment for most RFETS contaminated groundwater plumes based on the following

- Neither the UHSU and LHSU are capable of producing significant quantities of water as each has a relatively large clay content

- Aquifer tests conducted at RFETS show that, for the most part, aquifer yields are low, ranging from 6 x 10 gpm to 12 gpm, with an average of 0 3 gpm (EG&G, 1995a)

- Factors limiting water production within the UHSU include relatively thin saturated thicknesses and the presence of broad areas that become unsaturated during the fall and early winter (EG&G, 1995a)

- Surficial deposits (UHSU) at RFETS have hydraulic conductivities in the 10^{-3} to 10^{-4} cm/sec range Weathered and unweathered claystone bedrock (LHSU) have hydraulic conductivities in the 10^{-7} cm/sec range The valley fill alluvium is the most permeable unit, but no contaminant sources are present in this unit

- Due to the relatively low permeability of the geologic units at RFETS, cones of depression induced by groundwater removal would typically have very steep gradients requiring a large number of closely spaced wells to effectively implement pump and treat remediation

- Most of the RFETS groundwater contaminant plumes have sources consisting of dense nonaqueous phase liquids (DNAPLs) which are difficult to remediate by using pump and treat or passive methods because

  - DNAPLs have low dissolution rates in water and are denser than water, tending to sink to the bottom of the unit

  - The high clay content tends to adsorb DNAPL, making it difficult to impossible to remove

  - Pump and treat remediation of DNAPL-contamination often leaves behind pools of residual DNAPL which continue to act as a source, further releasing dissolved contaminants to the groundwater system

It may be possible to implement pump and treat where groundwater near the East Trenches where the No 1 Sandstone is contaminated However, a large number of closely spaced wells will be required to effectively pump and treat groundwater due to the low conductivities and the resulting steep cones of depression DNAPL contamination could easily remain after treatment For these reasons, and the associated higher costs for this methodology, pump and treat was not considered as the proposed remediation treatment in this area

DNAPL contamination is difficult and time consuming to treat, whether by active or passive remediation methods Small pools of DNAPL will generally remain, and will continue to release contamination into groundwater When properly placed, a passive collection system near the distal ends of plumes will effectively capture the DNAPL contaminated groundwater, but a contaminated plume will be left upgradient to naturally attenuate The contaminants in the plume will degrade with time, and upgradient water will flush the source material toward the collection system

Remedial actions were selected to be effective, inexpensive to install and operate, and require minimal plant infrastructure support For these and the preceding reasons, passive treatment actions were the preferred proposed remedial actions

Passive systems proposed for the contaminated groundwater plumes at RFETS include

- *In situ* passive collection and treatment system such as a funnel and gate where contaminated groundwater is funneled into a reactive barrier Treated water is released back into the groundwater flow system downgradient of the barrier These systems have been used effectively at other sites

- Collection of groundwater from springs, seeps, and/or shallow drains, then pumping the collected water to an existing treatment facility (i e , Building 891)

- Collection of groundwater from springs, seeps, and/or shallow drains, then using gravity to feed the collected water through a nearby, *ex situ* treatment system which uses granulated activated carbon, or reactive iron, or similar treatment options

The passive treatment methods proposed in this plan could use any of these methods

All proposed remedial actions are conceptual in nature No engineering feasibility analyses were performed and the proposed remedial actions were not evaluated with regard to changing site conditions over time Before implementation of any remedy, an evaluation will be done to determine the most appropriate, effective, implementable, and cost-effective remedy for each contaminated groundwater plume The result of these evaluations will be presented as part of ASAP or in a planning or implementation document such as an Interim Measure/Interim Remedial Action (IM/IRA) or Proposed Action Memorandum (PAM) along with the data used to make the decision It is possible that, as a result of these evaluations, different remedial actions will be selected for some of the groundwater contaminant plumes

Assumptions

The proposed conceptual groundwater remedial actions were developed using the following assumptions

- RFETS groundwater will not be used for domestic or other consumptive purposes, and there are no pathways for contaminated groundwater to directly impact human receptors

- Groundwater will be managed or remediated to protect surface water and to minimize potential ecological impacts due to entering the surface water system

- Source removals or containment of subsurface soil sources will be designed to prevent groundwater contaminant concentrations greater than 100 x MCLs

- Remediation and plume management will preserve wetlands where possible, and will be implemented using cost-effective methodologies

- Passive groundwater treatment or containment is the preferred remedial action

- Performance monitoring will be conducted for all treatment systems to verify the effectiveness of the treatment

- The remediation and management decisions described herein are based on the existing data set for groundwater contaminant plumes, as well as on known technologies that are believed to be applicable

- For this plan, the proposed remedial actions are assumed to be passive treatment or containment devices sited downgradient from the sources and coincident with the 100 x MCL boundary within the plume, or where otherwise practicable and feasible The actual remedial actions and location of these actions will be decided on a case-by-case basis and detailed in a IM/IRA or PAM before implementation

- An alternatives analysis for any proposed remedial action will be presented as part of ASAP or as an IM/IRA decision document or PAM

- All remedial actions will be consistent with the proposed end-state of the Site

4.2.2 IHSS 119.1 GROUNDWATER CONTAMINANT PLUME

The IHSS 119 1 drum storage area within OU 1 is the site of historic releases of chlorinated VOCs to the environment These solvents have resulted in the contamination of shallow alluvial groundwater (UHSU) and have formed a small, relatively stable contaminant plume extending down the 881 Hillside In 1992, a French Drain was installed to intercept contaminated groundwater perceived to be flowing down the 881 Hillside A three-foot-diameter recovery well, located within the source area, was also installed to recover water containing higher levels of dissolved VOCs

The French Drain is in operation and is collecting relatively uncontaminated groundwater for treatment at the Building 891 Treatment Plant The plume is upgradient of the French Drain and does not appear to be migrating The area immediately downgradient of the French Drain is unsaturated indicating that the French Drain has dewatered much of the area A small seep located south of IHSS 119 1 and downgradient of the French Drain along Woman Creek was

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sampled once This sample contained a trace amount of VOCs However, it is not clear if this seep is related to the contaminant plume

The final remedy planned for OU 1 is to excavate those soils containing solvent concentrations greater than the Tier-I action levels Excavating the source will also remove much of the groundwater contaminated above 100 x MCLs After demonstration that this proposed remedy has been effective, and that the source and much of the resulting contaminated groundwater has been removed, the French Drain and recovery well would be removed from operation

This remedial action will be protective of surface water, and should reduce any potential long-term stress to environmental receptors of contaminants that may reach Woman Creek

4.2.3 MOUND SITE GROUNDWATER CONTAMINANT PLUME

The Mound groundwater contaminant plume is poorly defined but it is suspected to migrate northward from the old Mound Site and discharge to South Walnut Creek downstream of the sewage treatment plant DNAPLs in the Mound area are suspected to be the source of the groundwater contamination and the potential exists for these concentrations to increase over time There is a possibility that Trench T-1 could contribute to this plume, however, evidence indicates the Mound Site is the primary source

Contaminated groundwater from the plume contains vinyl chloride, tetrachloroethene, and trichloroethene The contaminant plume is discharging through surface and subsurface seepage into South Walnut Creek The contaminant plume discharges at a rate of 5 gallons per minute or less at seep SW059 where it is collected and stored, then later treated at the Building 891 Treatment Facility

Remediation of the Mound Site contaminated groundwater plume will consist of excavating sources exceeding Tier-I action level for soil cleanup criteria for VOCs Trench T-1 will also be removed using the same criteria The remedial action proposed for the groundwater with concentrations of VOCs in excess of 100 x MCLs is to collect the plume front before impacting South Walnut Creek by making improvements to the existing seep collection system at SW059 The contaminated water could then be treated by a system installed along the south bank of South Walnut Creek

Containment and treatment of the Mound site groundwater contaminant plume will result in a reduction of risk to the environment posed by uncontrolled of contaminated groundwater releases to surface water

4.2.4 THE 903 PAD AND RYAN'S PIT GROUNDWATER CONTAMINANT PLUME

This groundwater contaminant plume has two, closely spaced sources (1) VOCs associated with drums stored at the 903 Pad which leaked into the subsurface and groundwater, and (2) Ryan's Pit where VOCs were disposed of in a trench The groundwater contaminant plume flows southward from these sources towards the South Interceptor Ditch and Woman Creek The groundwater is contaminated with carbon tetrachloride, tetrachloroethene, trichloroethene and other VOCs The highest concentrations of VOCs in groundwater are near the 903 Pad and Ryan's Pit sources, although isolated areas of high concentration have been observed within the plume away from these sources Pure phase DNAPLs were found during the excavation of Ryan's Pit and are assumed to exist underneath the 903 Pad

Contaminated groundwater occurs in the UHSU in alluvium, colluvium and weathered, low-permeability bedrock where it forms a complex plume, or plume group Depending on the season, there may be many unsaturated areas within the plume Groundwater flow paths in alluvial materials are relatively well-defined by contact seeps with the underlying bedrock materials and by numerous wells However, groundwater flow through the hillside colluvium and bedrock is poorly understood Areas of unsaturated colluvium are fairly common and prediction of local flow paths is difficult Discharge of contaminated groundwater has not been observed from the colluvium or weathered bedrock portion of this plume

Contaminated groundwater containing tetrachloroethene and trichloroethene may eventually enter the South Interceptor Ditch and Woman Creek surface water pathways if no actions are taken to manage this plume Discharge of contaminated groundwater into Woman Creek would pose a potential risk to the environment Capture and treatment of the 903 Pad and Ryan's Pit groundwater contaminant plume will reduce the risk to the environment posed by uncontrolled releases to surface water

The proposed remedy is to remove contaminant sources exceeding the applicable RFETS soil cleanup criteria for VOCs from the 903 Pad area Removal of the subsurface soils in the Ryan's Pit area has already been completed Further groundwater remediation is proposed as a plume capture and treatment system proposed to be installed at or near the MCL plume boundary which appears to be close to the 100 x MCL isopleth Monitoring of treated groundwater and groundwater downgradient of the collection facilities for plume constituents would be conducted to ensure system performance Active groundwater collection systems are not considered feasible for this area because of low hydraulic conductivities, limited saturated thicknesses, limited area extent of saturated zones, and complex interaction of groundwater between colluvial and bedrock units

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4.2.5 118.1 GROUNDWATER CONTAMINANT PLUME

IHSS 118 1 is located due north of Building 776 and east of Building 730 There are documented past releases of chlorinated solvents (i e , carbon tetrachloride) at this site The area where IHSS 118 1 is located also includes overlap from other IHSSs (i e , 121-T9, 121-T10, 131, and 144[N]) and different spills and occurrences are associated with these IHSSs

IHSS 118 1 is the site where a 5,000 gallon underground steel storage tank and associated piping were formerly located Numerous reported spills have occurred, some between 100 to 200 gallons, before 1970 as documented in the Historical Release Report The tank ultimately failed in June of 1981 and was subsequently removed, along with a limited amount of soil surrounding the tank The carbon tetrachloride released from IHSS 118 1 has contaminated surrounding soils and the UHSU groundwater

These releases have formed a contaminated groundwater plume, which may eventually reach the North Walnut Creek drainage During the recent field sampling program, four soil borings were installed near the IHSS 118 1 Two soil borings intercepted 6 to 8 inches of free phase carbon tetrachloride at a depth of approximately 25 to 27 feet Significant soil contamination was also discovered in soil samples of several borings

The are two potential remedial actions for IHSS 118 1 groundwater contaminant plume (1) source removal by using shallow recovery wells to remove as much of the free phase carbon tetrachloride as possible, and (2) removal of the soils, adjacent tanks, and associated piping In addition, the potential remedial action includes the installation of a containment wall around the area at approximately the 100 x MCL boundary, and capping the area with a soil vegetative cover and/or regrading to limit recharge and contaminant leaching

4.2.6 GROUNDWATER CONTAMINANT PLUMES IN THE EAST TRENCHES AREA

A large groundwater contaminant plume is located in the East Trenches area The sources are IHSS 110 (Trench T-3) and 111 1 (Trench T-4) with a minor upgradient contribution from the VOCs in the 903 Pad area The trenches were used to bury sewage sludge from the sewage treatment plant, but also contain crushed drums and DNAPLs Contaminated groundwater occurs within the UHSU, in the alluvium and in the Number 1 Sandstone in hydraulic connection with the alluvium The major contaminants are carbon tetrachloride, tetrachloroethene, and trichloroethene as well as other VOCs

The downgradient boundary of the groundwater contaminant plume is located at a spring and seep complex on the south bank of South Walnut Creek, above Ponds B-1 and B-2 where the Number 1 Sandstone subcrops Concentrations of VOCs above 100 x MCLs have been detected by a recent sampling program conducted at the seep complex

A lobe of this groundwater contaminant plume extends to the east of the trench area in the alluvium This lobe of the contaminant plume does not reach surface water Uncontaminated alluvial groundwater discharges downgradient to this lobe as seeps in an unnamed tributary drainage to South Walnut Creek This lobe will continue to be monitored

The preliminary remedial action is to perform source remediation, if feasible, for Trenches T-3 and T-4 to remove subsurface soils that exceed the applicable RFETS soil cleanup criteria for the Tier-I action level for VOCs This action is scheduled to occur in FY96 The potential groundwater remediation proposed is to install a plume capture system near South Walnut Creek and possibly to use passive technologies to treat the contaminated groundwater

There are potential ecological impacts since water from the contaminant plume containing tetrachloroethene and trichloroethene has reached South Walnut Creek If concentrations in these seeps increase over time, a greater contaminant mass may reach surface water Capture and treatment of the contaminant plume in the East Trenches area will reduce risk to the environment posed by contaminant migration to the surface water system

4 2.7 IA GROUNDWATER CONTAMINANT PLUME

The IA contains a coalesced plume of contaminated groundwater containing trichloroethene thought to emanate from IHSSs 117 1, 117 2, 157 1, 158, and 171, tetrachloroethene thought to emanate from IHSSs 117 1, 117 2, 158, 157 1, 160, and 171, and carbon tetrachloride thought to emanate from IHSSs 117 1, 117 2, and 158 This coalesced plume southwest of Building 559, is outside of the fenced portion of the protected area (PA) and extends downgradient towards the central portion of the PA

Currently, the groundwater contaminant plume does not appear to be moving, and there are no known or potential surface water impacts Proposed remedial actions include removal of soils containing contamination above the Tier-I action level where feasible, and installation of a soil vegetative cover to limit natural recharge and contaminant leaching, with continued monitoring of the groundwater contaminant plumes Groundwater recharge in the IA caused by water losses from sewers and water supply pipelines, as estimated from water budget studies from surface water monitoring activities, is between 7 and 26 million gallons per year Reduction of recharge from these sources could significantly reduce the potential for contaminant migration in the subsurface

Other alternatives under consideration for remedial actions include diverting groundwater flow upgradient of the IA, and collecting contaminated groundwater within the IA by linking footing drains on selected buildings with new sections of horizontal drains connected to the existing treatment facility in Building 891 Preliminary calculations indicate that only 15 percent of the present recharge (precipitation plus groundwater influx) to the IA could be diverted by an upgradient barrier If the upgradient barrier diverts only 3 6 gallons per minute of groundwater flux from entering the IA, then there appears to be little benefit to justify the significant cost for materials and installation

Treatment of contaminated groundwater within the IA does not appear to be necessary to protect surface water, as the plume appears to have limited potential for migration However, ongoing monitoring and evaluation of the groundwater through the monitoring program will continue, and will detect if movement or expansion of the plume is occurring Groundwater remedial actions may become necessary if the contaminant plumes increase significantly and become a threat to surface water

4.2.8 ADDITIONAL PLUMES

The Landfill and Solar Ponds groundwater contaminant plumes do not contain VOCs in groundwater with concentrations above 100 x MCLs However, these plumes are of interest as these are associated with RCRA units The setting and status of these plumes is discussed below

Landfill Plume

Groundwater contaminant plumes are located south and west of the current landfill pond, including a portion of OU 7 Aluminum, manganese, zinc, 2-methylnaphthalene, naphthalene, benzene, and possibly methylene chloride are present downgradient of the current landfill, with average values exceeding MCLs Contaminants above MCLs may reach surface water if some remedial action is not taken

An interim remedial action currently under construction will include the installation of a gravity flow system designed to collect the contaminated groundwater and leachate flowing from the landfill for treatment This system will consist of cement vaults collecting the contaminated water through a gravity-driven system Treatment will include a settling basin, bag filter to remove additional suspended solids, and granular activated carbon to remove organic chemical constituents Modifications to this design may be required if long-term treatment is determined to be necessary Contaminated water will be treated to comply with established cleanup levels This treatment should effectively mitigate the potential ecological risk from the contaminants of concern

Solar Ponds Nitrate Groundwater Contaminant Plume

The Solar Ponds area has historically released nitrates to the environment The released nitrates have contaminated UHSU groundwater which forms a plume that extends northward from the Solar Ponds to the Walnut Creek drainage above Pond A-1 A small lobe of this nitrate plume extends to the southwest for a short distance This contaminant plume does contain nitrates at concentrations above 100 x MCLs Nitrate concentrations within the plume are decreasing with time, but still exist at high levels The Interceptor Trench System (ITS) was installed to intercept contaminants and capture the nitrate plume and was recently replumbed in order to increase its effectiveness The ITS captures 2 7 million gallons of water per year, but is not entirely effective in preventing nitrate contamination from impacting the North Walnut Creek drainage

Proposed remedial actions for the groundwater nitrate plume, if required, will be developed at a later date based on final cleanup standards and site-specific hydrogeologic conditions No source removal is planned for nitrate-containing media However, a soil-vegetative cover is being considered which would reduce the mass flux

Recent negotiations may make it possible to change the stream classification downgradient of the nitrate plume from drinking water to agricultural, recreational, and protective of aquatic life There is some possibility that this surface water will be used for irrigation If the drinking water classification is lifted, then the nitrate concentrations seen in the surface water as a result of the nitrate plume are acceptable for all of the proposed uses, and could be of benefit to irrigation uses

4 3 PLUME RANKING

When a source or contaminant plume is identified above action levels and determined to be a candidate for remedial actions, a prioritization process is used to determine the sequence in which remediation will occur A methodology was developed by CDPHE, EPA, KH, and RMRS staff to rank the known environmental risks at RFETS This methodology is outlined in the "Environmental Restoration Ranking" (September 1995) Sites are ranked according to 1) a factor related to concentrations of contaminants present in soil, subsurface soil, and groundwater, 2) a factor characterizing the mobility of the contaminants, and the proximity to surface water, and 3) the potential for further release factor which quantifies the possibility that source material will continue to be released into the environment The resulting prioritized list is used to determine the general order to implement remedial actions, not as a specific sequence of remediation

The groundwater contaminant plumes described in this document were ranked using this methodology except the mobility factor was replaced by a factor estimating the impact of the groundwater contaminant plume on surface water The three factors and how they were applied to obtain the plume ranking are

1) **Score Ratio** Concentrations of VOCs in groundwater from 1990 on were compared to the proposed action levels of 100 x MCLs The maximum ratio for each analyte within the contaminant plume was tabulated, and a total score for each groundwater plume was calculated by summing the maximum ratios As in the original ranking, to minimize the impact of high levels of contaminants on the overall rankings, Table 4-1 was used to convert these summed values to a Score Ratio for each contaminant plume

2) **Impact to Surface Water** A rating of 1 to 3 was assigned to each plume based on the evaluation of whether a groundwater contaminant plume was impacting surface water (a rating of 3), had the potential to impact surface water (a rating of 2), or did not pose a threat to surface water at this time (a rating of 1) As all plumes are relatively slow moving, the velocity of the groundwater was not a factor

3) **Potential for Further Release** The potential for contaminants to continue to migrate into groundwater (i e is an uncontained source present?) A rating of 1 to 3 is assigned based on this evaluation

The results of the plume ranking is shown in Table 4-2 When the ER Priority List is regenerated using the action levels and standards currently under negotiation, the groundwater contamination plume rankings will be incorporated However, the rankings generated for the groundwater contaminant plumes were compared to the existing ER Priority List to estimate where these actions might be ranked

Table 4-1 Conversion Table for Scores

Total Groundwater Score	100 x MCL Score
> 501	10
251 – 500	9
101 – 250	8
76 – 100	7
51 – 75	6
31 – 50	5
21 – 30	4
11 – 20	3
6 – 10	2
1 – 5	1

The following is an example showing how these factors were used to generate the ranking for the 903 Pad groundwater contaminant plume Concentrations of VOCs in groundwater in the 903 Pad and Ryan's Pit plume were identified and compared to the appropriate 100 x MCL value The maximum ratios for each contaminant that exceeded 100 x MCL were summed, which equaled a value of 603 Using Table 4-1, this value equated with a Ratio Score of 10

Next, the mobility of the contaminants was evaluated Because the contaminants are VOCs, and the area is near surface water, the maximum value of 3 was used The potential for further release was believed to be high and a factor of 3 was assigned based on the belief that there is free product underneath the 903 Pad which is still being release into the groundwater Finally, the impact to surface water from this groundwater contaminant plume was evaluated Because the contaminant plume is close to surface water, this was rated as a 3

Multiplying the Ratio Score of 10 times the impact to a surface water factor of 3, and the potential for further release of 3, generated a ranking score of 90

Table 4-2 Plume Ranking

Rank	Plume Location	Total Plume Groundwater Location Score	Ratio Score	Impacts to Surface Water Multiplier	Potential for Further Release Multiplier	Total Priority Score	Relative ER Priority List Rank
1	903 Pad/Ryan's Pit Plume	603 4	10	3	3	90	1
2	East Trenches Plume	256.8	9	3	3	81	4
3	Mound Plume	187.9	8	3	2	48	7
4*	IHSS 118 1	53.2	6	2	3	36	11
5*	IHSS 119 1 Plume (OU1)	87.9	7	2	1	14	13
6*	Solar Ponds Nitrate Plume	16 7	3	1	1	3	33
7*	South IA Plume	11.9	3	1	1	3	33
8*	Landfill Plume (IHSS 114)	—	—	—	—	—	**

Note

*Below 100 x MCLs Action Levels

**No ranking values shown because the contaminant concentrations did not approach 100 x MCL (evaluated under RCRA)

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5.0 CONCLUSIONS AND NEXT STEPS

The specific goals of the Groundwater Strategic Plan are to provide a strategy consistent with the Vision and the Action-Level Framework for surface water, groundwater, and soils, to identify and describe the salient groundwater plumes, rank the groundwater plumes in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995), and provide an initial planning basis for work package development and funding

To meet these goals, the strategy proposes source removal, where possible, provides for source control, where necessary and provides for the treatment of dissolve phase plumes, where necessary The strategy includes an evaluation allowing some areas of contaminated groundwater to remain in place where the goals of the strategy can be met without active intervention

Action levels for groundwater must be protective of surface water standards and quality as well as the ecological resources As stated in the draft Conceptual Vision, domestic use of groundwater at RFETS will be prevented through institutional controls Since no other human exposure to groundwater is foreseen by the Vision, groundwater action levels are not based on human health protection The protectiveness of surface water will be achieved by applying MCLs as groundwater action levels A two-tier approach to groundwater remediation and monitoring is being proposed

The previously ranked IHSSs and the ranking of groundwater plumes presented in Section 4 1 provide the basis for establishing the priority and sequence of remedial actions However, a schedule for implementing groundwater remediation will be dependent on factors such as funding, data sufficiency, resource availability, and the integration with other remedial and site activities The emphasis of the proposed near-future groundwater remedial actions will be on the removal of source material outside of the IA

Installation of the three new Tier II groundwater monitoring wells is necessary to provide a means to determine if the plumes are advancing towards surface water These wells are intended to provide an early warning that remedial actions may be required under the Action Level Framework described in Section 3 0

The unknown extent of the chlorinated solvent plumes associated with the PU&D yard (IHSS 170, 174a and 174b) is a major data gap Because the nature of the southern boundary of these plumes is undetermined, the potential impact to surface water can not be evaluated A limited investigation of the hillslope hydrology including the installation of several new groundwater monitoring wells near North Walnut Creek is recommended

Before each remedial action can begin, certain pre-construction activities must be completed These activities include, but are not limited to, additional investigations to determine the optimal location of the remedial device, analysis of alternatives, and engineering design The success of any given groundwater remedial device will be dependent on having an adequate understanding of the local hydrogeology and pathways Costs for these additional subsurface investigations can be minimized by using site-owned Geoprobe equipment as an alternative to employing conventional hollow-stem auger techniques provided by a drilling subcontractor

The following proposed conceptual actions would be the direct result of applying the action levels for groundwater remediation within the framework of the Vision

- Contaminated soils in OU 1 (IHSS 119 1) above action levels would be excavated, thereby removing material above the Tier-I Action Level Since the source of groundwater contamination would be removed, the use of the French Drain system and recovery well eventually would no longer be necessary Monitoring will demonstrate the effectiveness of the remedy

- In OU 2, sources exceeding Tier-I Action Levels will be removed to the extent practical Contaminated groundwater will be collected by systems installed on the hillsides Groundwater would be directed to a treatment system The capture structures would be located approximately at the 100 x MCL boundary on the down gradient side of the plume where surface water is determined to be potentially at risk

- Known areas of carbon tetrachloride sources would be evaluated for potential excavation near IHSS 118 1 where feasible The ITS currently located down gradient of the Solar Ponds would be removed from service An impermeable barrier may be installed to contain the portion of the chlorinated solvent plume that exceeds the 100 x MCL contaminant concentration in groundwater

- A gravity flow treatment system will be installed to treat leachate and contaminated groundwater flowing from the present Landfill However, the current system is designed as an interim measure Modifications may be required for long term use

- A soil vegetative cover and regrading would be used where necessary to limit natural recharge caused by precipitation from leaching of contaminants in the unsaturated zone This approach is predicted to reduce the movement of groundwater through the IA and thereby reduce the mobility of the plumes Subsurface sources of groundwater contamination would be removed where practical At the end of the D&D/remediation phase, the plant water supply and sanitary sewer would be shut off This would eliminate a major source of groundwater recharge for the IA and should greatly reduce the mobility of plumes originating from the IA

Further analysis is required to determine optional intercept locations, actual treatment methodologies and cost-effective project sequencing

6.0 REFERENCES

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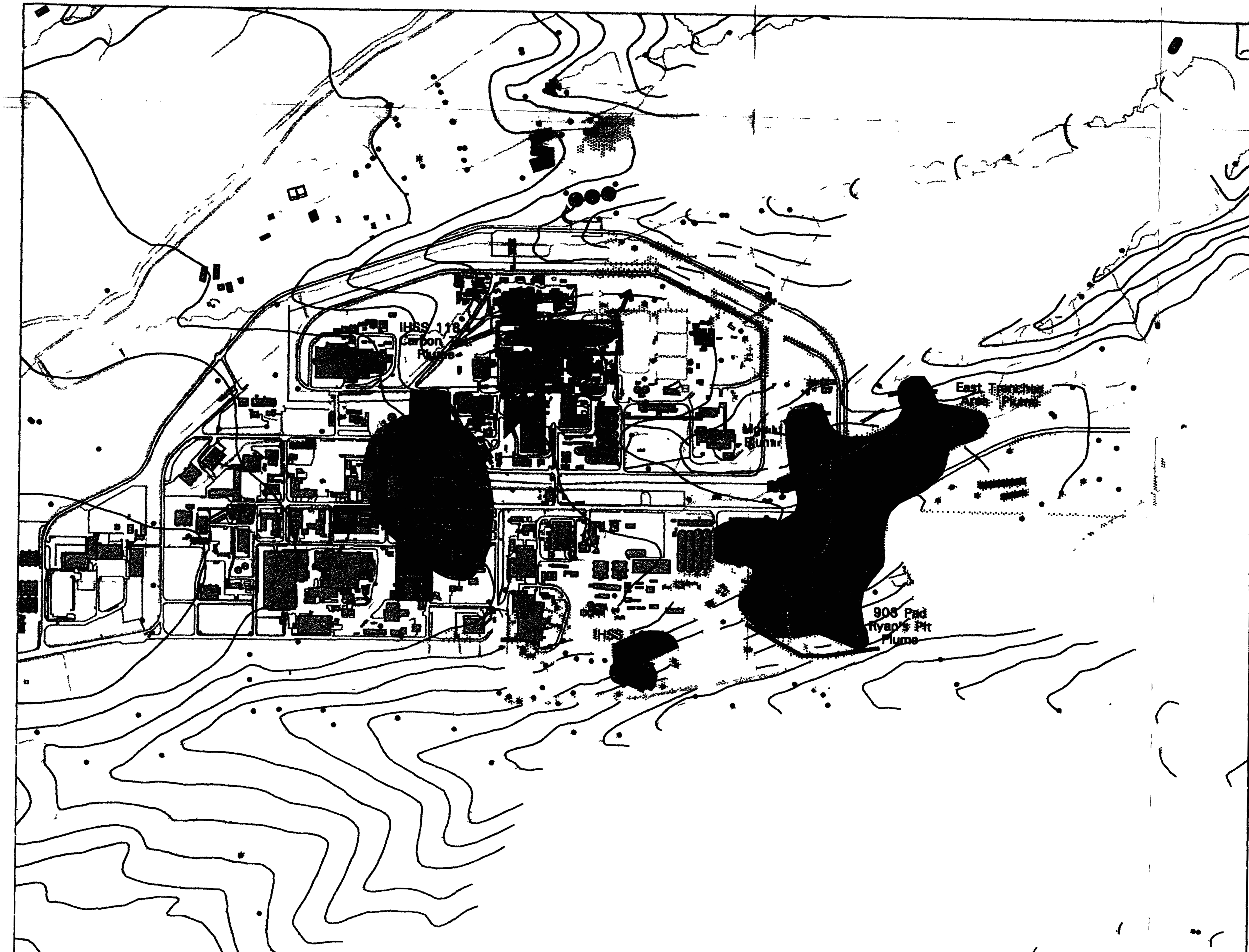

Potential Remedial Actions with Composite Plume Extent for Concentrations > 100 x MCLs

Contamination extent boundaries represent groundwater sampling results for TCE, PCE, CCl4, and VC.

LEGEND

- Surficial Unit Groundwater Contour
- Groundwater Flow Direction
- OU 7 Remediation Installation
- Remediation Installations
- Containment Wall
- Plume Intercept Location
- Well With Contam > 100 X MCLs
- UHSU Wells
- Buildings
- Suspected VOA Source
- Pavement
- Surface Drainage
- Unsaturated Surficial Materials
- Concentrations > 100 X MCLs

N

400 0 400 800 Feet

Figure 4 1

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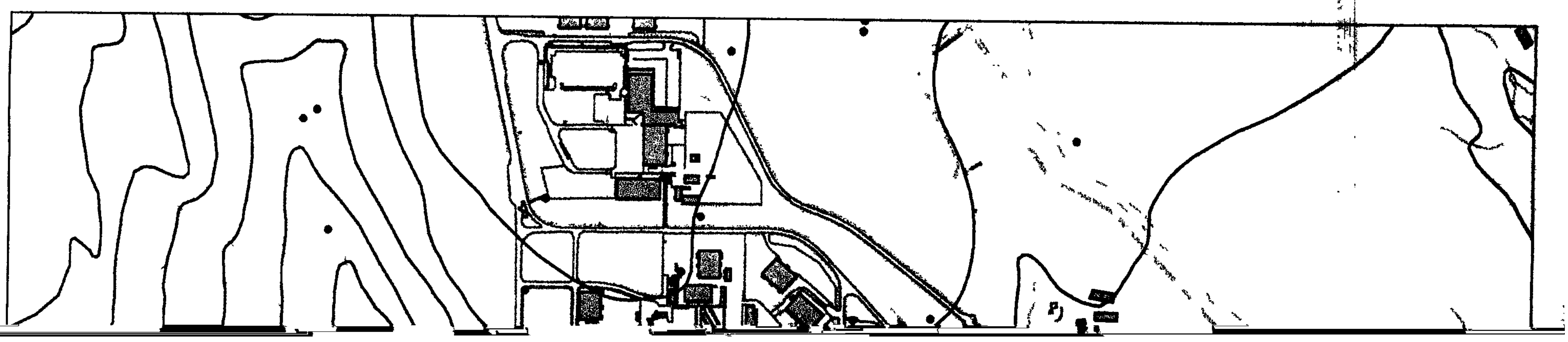

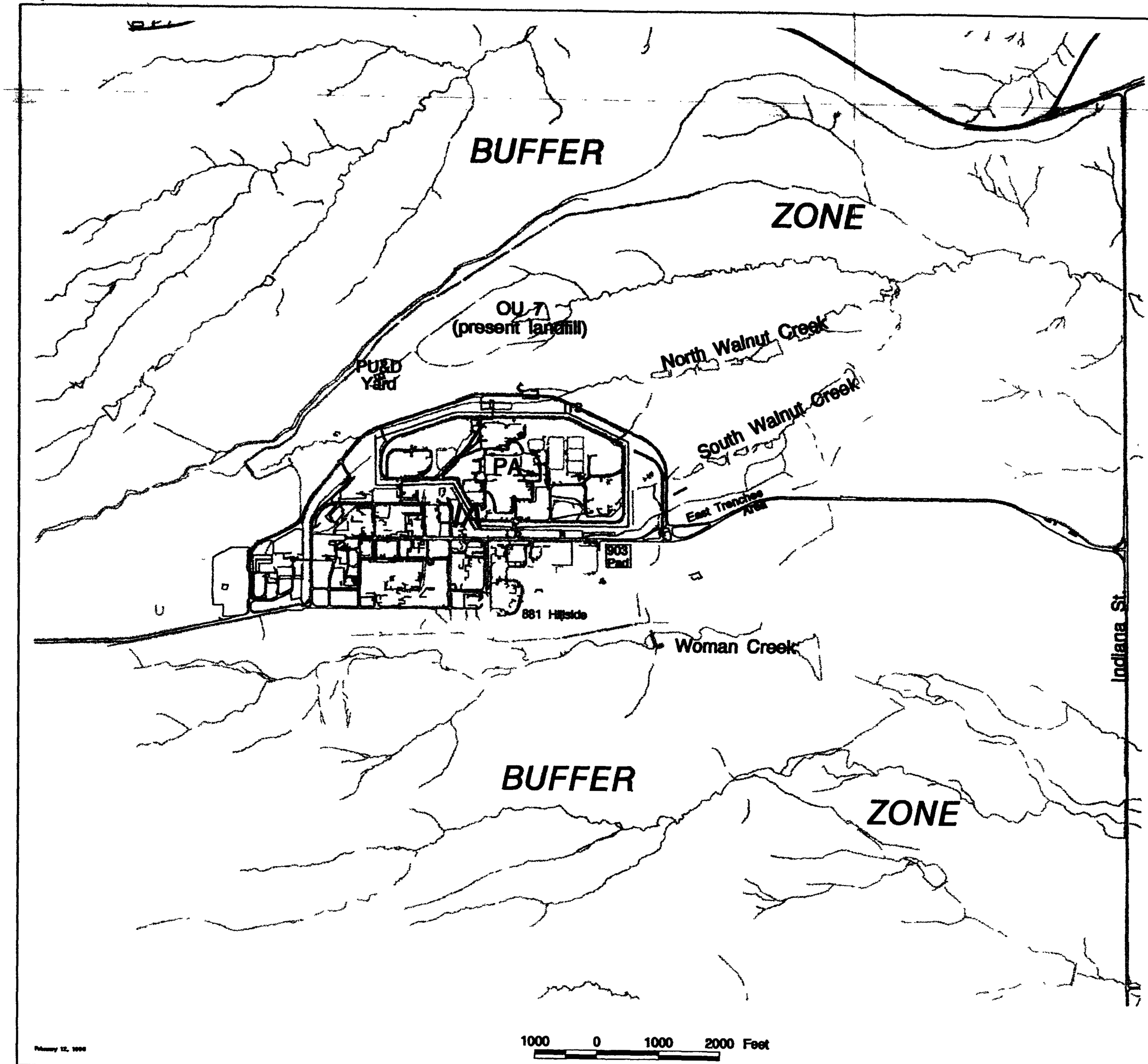

Location Reference Map

Location of areas of interest refered to in text.

Figure 1 1

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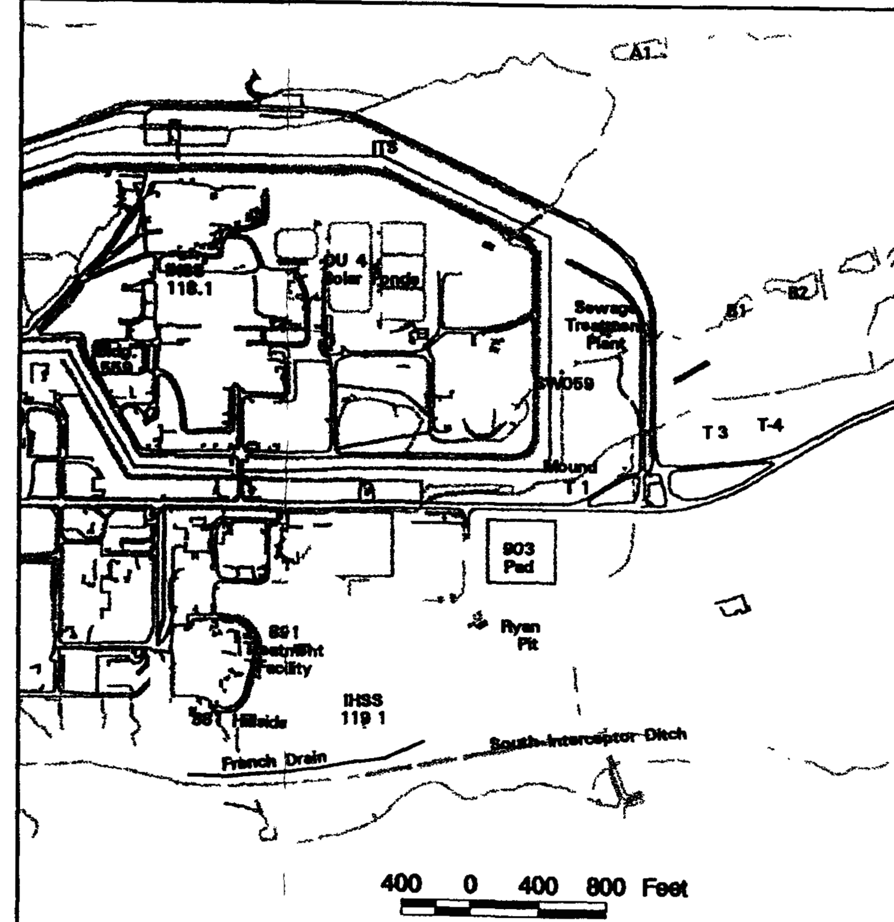
Detailed View of Industrial Area



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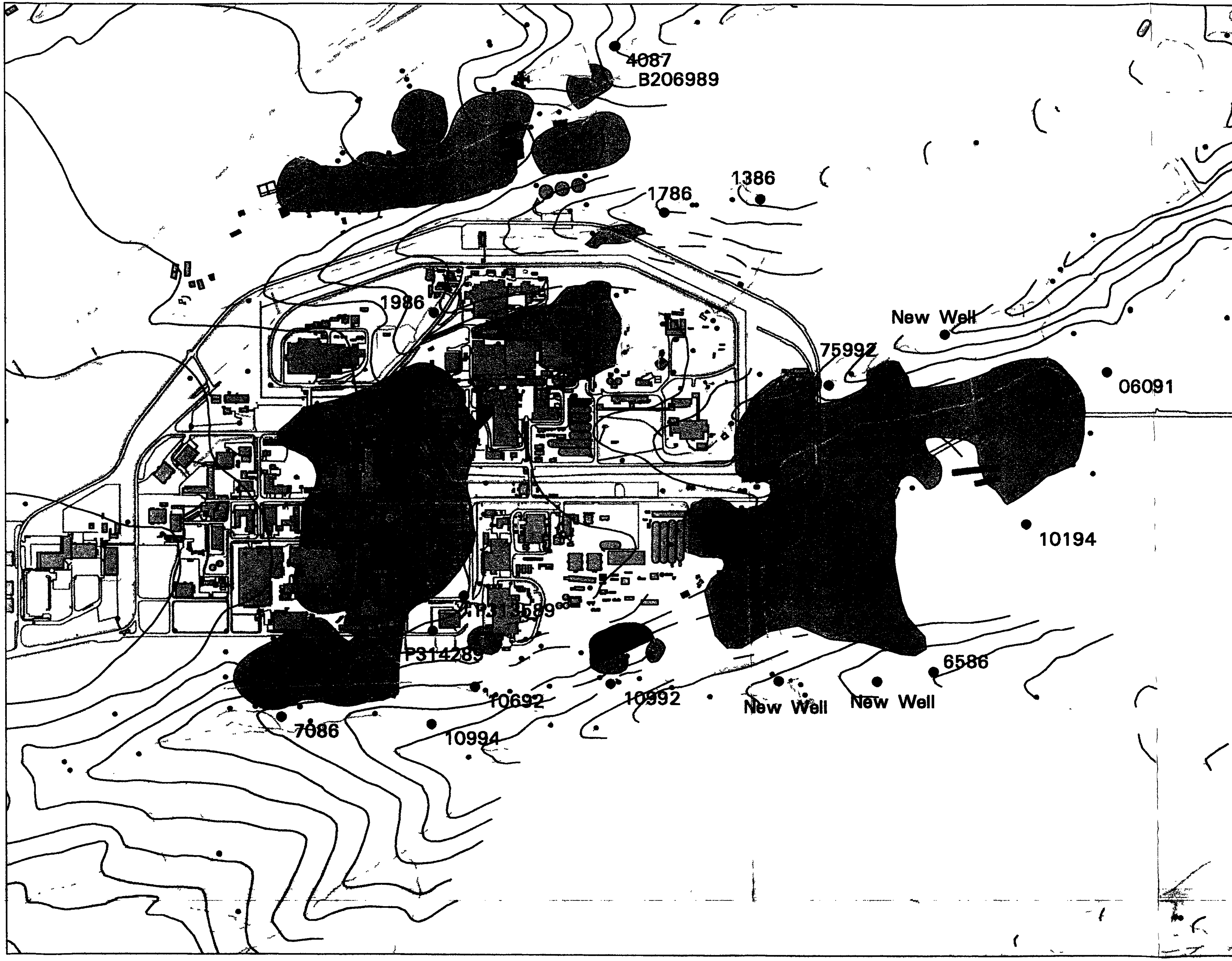

Tier II Well Location Map with Composite Plume Extent for Concentrations > MCls

Contamination extent boundaries represent groundwater sampling results for TCE PCE CCl4 and VC

LEGEND

- Tier II Wells
- Surficial Unit Groundwater Contour
- Groundwater Flow Direction
- OU 7 Remediation Installation
- Well With Contam 100 X MCLs
- UHSU Wells
- Buildings
- Suspected VOA Source
- Pavement
- Surface Drainage
- Concentrations MCLs

N

400 0 400 800 Feet

Figure 3-1

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